ZooKeys 1278: 225–244 (2026)
DOI: 10.3897/zookeys.1278.182033

Research Article

# A new species of *Arabella* (Annelida, Polychaeta, Oenonidae) from the sea off Gouqi Island, Zhejiang, China

Yehoshafati Elton Anton[1], Amiri Rajabu Mohamedi[1], Yongjiu Chen[1]

1 *College of Marine Science and Technology, Zhejiang Ocean University, Changzhi Island, Zhoushan, Zhejiang 316022, China*
*Corresponding author: Yongjiu Chen (yongjiu.chen@gmail.com; yongjiuchen@zjou.edu.cn)*

## Abstract

*Arabella* is the second-most diverse genus in the family Oenonidae, with about 50 species known so far. However, until now, there has been no detailed taxonomic information on *Arabella* species in the East China Sea. In this study, we describe a new species, *Arabella gouqi* **sp. nov.**, discovered in the sea off Gouqi Island, Zhejiang, China, using integrated morphological and molecular evidence. This species is characterized by the following features: a pygidium with two swollen pads, short notopodial cirri, a bifid robust left and a gracile falcate right maxilla I (MxI), short left and long right maxilla II (MxII), a posterior postchaetal lobe shorter than the chaetae, and gradually tapering of the ventralmost chaetae. Phylogenetic analysis based on both COI and 16S rDNA gene sequences showed that *A. gouqi* **sp. nov.** forms a distinct, fully supported monophyletic clade. These findings were further supported by substantial Kimura 2-parameter (K2P) genetic distances between the new species and other reported *Arabella* species, which ranged from 9.9% to 24.2% for COI and from 5.5% to 25.2% for 16S rDNA. This study provides essential data for understanding the taxonomy of *Arabella* in the East China Sea and emphasizes the need for further research on this group in the region.

**Key words:** 16S, *Arabella gouqi* sp. nov., COI, morphology, new record, Oenonidae, taxonomy

OPEN ACCESS

**Academic editor:** Greg Rouse
**Received:** 10 December 2025
**Accepted:** 24 March 2026
**Published:** 30 April 2026

**ZooBank:** https://zoobank.org/A07B80AD-A9F2-434B-B4F7-E1BF70358B61

**Citation:** Anton YE, Mohamedi AR, Chen Y (2026) A new species of *Arabella* (Annelida, Polychaeta, Oenonidae) from the sea off Gouqi Island, Zhejiang, China. ZooKeys 1278: 225–244. https://doi.org/10.3897/zookeys.1278.182033

**Copyright:** © Yehoshafati Elton Anton et al. This is an open access article distributed under terms of the Creative Commons Attribution License (Attribution 4.0 International – CC BY 4.0).

## Introduction

*Arabella* Grube, 1850, is the second-most diverse genus in the family Oenonidae, Kinberg, 1865, contributing about 76% of the family species when combined with the genus *Drilonereis* (Zanol et al. 2021; Darbyshire and Kara 2024). Presently, about 50 valid species of *Arabella* have been reported worldwide (Read and Fauchald 2025), distributed from the intertidal zone to the abyssal depths (Steiner and Amaral 2009; Zanol and Ruta 2015; Zanol et al. 2021). The study of this group requires careful observation of the maxillary apparatus, notopodial cirri, the pygidium, and the ventralmost chaeta, as its taxonomy is mainly based on the differences in these structures (Colbath 1989; Zanol and Ruta 2015; Zanol et al. 2021; Darbyshire and Kara 2024).

For a long time, *Arabella* was reported as a cosmopolitan genus; a good example is *Arabella iricolor* Montagu, 1804, originally described from South Milton in the UK. After its original description, the name was further used

for other specimens outside of Europe (Imajima and Hartman 1964; Uchida 1968; Fauchald 1970; Rho and Song 1975; Mohammad 1981; Paik 1989; Wang and Huang 1993; Blake et al. 1995; Ribeiro et al. 2018; Darbyshire and Kara 2024; Kang et al. 2024). This is because many earlier taxonomists did not examine crucial diagnostic features such as the maxillary and parapodial structures (Imajima and Hartman 1964; Uchida 1968; Paik 1989; Zanol and Ruta 2015; Darbyshire and Kara 2024; Kang et al. 2024). As a result, the idea that *Arabella* is found all over the world likely stems from inadequate descriptions (Darbyshire and Kara 2024; Kang et al. 2024). The actual diversity in the genus has likely been underestimated (Zanol and Ruta 2015; Ribeiro et al. 2018; Zanol et al. 2021; Darbyshire and Kara 2024). Using new morphological details, along with molecular tools, helps us sort out these species and fill in the molecular data, which are still limited (Zanol et al. 2021; Darbyshire and Kara 2024).

This study presents the first record of a species of the genus *Arabella* collected from the sea off the coast of Gouqi Island, Zhejiang, China, based on morphological and molecular evidence. We utilized the mitochondrial cytochrome *c* oxidase subunit I (COI) gene sequence, which has an appropriate evolutionary rate for characterizing variations among closely related species and geographical populations in various marine organisms, including polychaetes (Park 2018; Kara et al. 2020). To increase the confidence of our description, we also sequenced the mitochondrial 16S ribosomal RNA gene. This work constitutes the first documented occurrence of *Arabella* in the East China Sea, supported by integrated morphological and molecular evidence.

## Materials and methods

### Sample collection and morphological identification

A total of eight specimens were collected from four localities (Fig. 1) in mussel farms, specifically from the ropes holding mussels in the sea off Gouqi Island, Zhejiang, China. They were first anesthetized using a 7% magnesium chloride ($MgCl_2$) aqueous solution (Darbyshire 2014; Bonyadi-Naeini et al. 2016), then transferred into 90% alcohol for storage, and finally stored at -4 °C for further morphology and molecular identification. During laboratory analysis, body pictures of the specimens were examined using two stereomicroscopes (SZX2-ILLTQ, Olympus, Japan; S9i Leica).

About six specimens were dissected using a thin razor blade under the S9i Leica microscope. When required, we used proteinase K solution to remove tissue and expose internal structures, including maxillae, mandibles, and ventral and dorsal carriers. The targeted body features, including maxillae, mandibles, and chaetae, were mounted on slides with a drop of water, then the slides were observed, and images were captured using both the Olympus SZX2-ILLTQ stereomicroscope and a compound light microscope (Nikon ECLIPSE Ni; China). The nomenclature for maxillary plates and formulae followed the traditional classification of Colbath (1989), Steiner and Amaral (2009), and Zanol et al. (2021). The materials examined in this study were deposited at the Marine Biology Museum of Zhejiang Ocean University in Zhoushan, China.

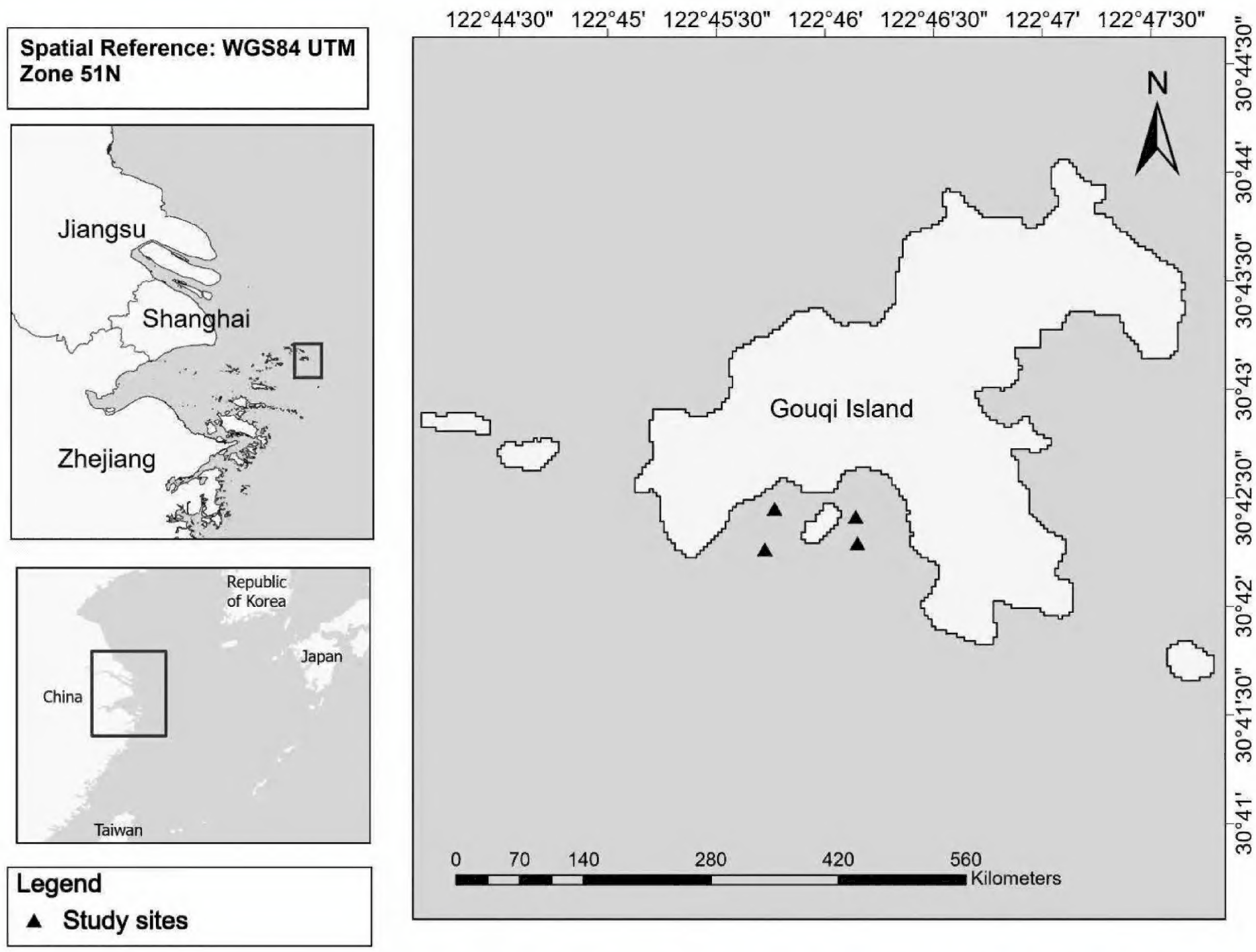


**Figure 1.** Sampling sites of specimens of *Arabella gouqi* sp. nov. off the coast of Gouqi Island, Zhejiang, China.

## Molecular analysis

The genomic DNA was isolated from eight tissue samples preserved in 75% ethanol, following the method described by Aljanabi and Martinez (1997). We used procedures provided by Sangon Biotech (Hangzhou) Co., Ltd, China. PCR was used to amplify both the COI gene and 16S rDNA, using the primer pairs listed in Table 1. PCR runs took place on a C1000 Touch Thermal Cycler with a total volume of about 18.5 µl that contained 12.5 µl of Taq Master Mix (New England Bio Labs), 1 µl of nuclease-free water, 1 µl of forward and reverse primer (10 µM), and 0.8–2.7 µl of template DNA depending on sample concentration.

The thermal cycling conditions for COI involved 94 °C for 4 min, then 35 cycles of 94 °C for 45 s, 47 °C for 30 s, and 72 °C for 1 min, and finally 7 min at 72 °C. For 16S, thermal cycling conditions started with 95 °C for 3 min, followed by 35 cycles of 94 °C for 1 min, 45 °C for 45 s, and 72 °C for 1 min, and finally 7 min at 72 °C. PCR results were examined by electrophoresis on a 1% agarose gel. The successful samples were then delivered to Sangon Biotech Company in Hangzhou http://www.sangon.com) for bidirectional sequencing. Finally, seven samples for 654 bp COI and four samples for 555 bp 16S rDNA were sequenced successfully.

**Table 1.** The list of primer sets used in this study.

| Gene | Primer name | Primer sequence (5'–3') | Reference |
|---|---|---|---|
| COI | polyLCO | GAYTATWTTCAACAAATCATAAAGATATTGG | Carr et al. 2011 |
| | polyHCO | TAMACTTCWGGGTGACCAAARAATCA | |
| 16S | 16SarL | CGCCTGTTTAACAAAAACAT | Palumbi 1996 |
| | 16SbrH | CCGGTCTGAACTCAGATCACGT | |

## DNA data analysis

Preliminary classification was conducted using NCBI nucleotide BLAST and BOLD identification by searching for the most closely related sequences to our specimens (Zhang et al. 2000). Species belonging to the family Eunicidae were used as outgroup taxa, while those in the families Oenonidae and Lumbrineridae were included as ingroup taxa for both COI and 16S phylogenetic analyses; additional *Arabella* species from different localities were analyzed for better comparisons (Table 2). The sequences of both COI and 16S genes were aligned using the ClustalW multiple alignment method (Thompson et al. 1994), then trimmed and edited in BioEdit v. 7.7.1 (Hall 2011). By using both Bayesian Information Criterion (BIC) scores and Akaike Information Criterion (AIC) values, GTR+G was selected as the best-fit substitution model for both COI and 16S (Nei and Kumar 2000). A maximum likelihood (ML) phylogeny was inferred in MEGA X v. 12 (Kumar et al. 2024) with 1000 bootstrap replicates (Felsenstein 1985). The two phylogenetic trees were taken separately into FigTree v. 1.4.4 for visualization and editing (Rambaut 2012). The pairwise interspecific distances for both COI and 16S sequences were computed in MEGA X v. 12.1.0 using the Kimura 2-parameter (K2P) model with 1000 bootstrap replicates (Kimura 1980).

# Results

## Systematic accounts

**Class Polychaeta Grube, 1850**
**Order Eunicida Dales, 1962**
**Family Oenonidae Kinberg, 1865**
**Genus *Arabella* Grube, 1850**

***Arabella gouqi* sp. nov.**
https://zoobank.org/889762FB-831B-4372-A35D-3D0FAE9B1653
Figs 2A–F, 3A–H, 4A–D

**Material examined. *Holotype*.** • 1 complete specimen (CMSTT7): CHINA: Zhejiang: Zhoushan; Gouqi Island, 30°42.4546'N, 122°45.7676'E, 20 m depth, 13 Oct 2025, Anton YE leg. ***Paratypes*.** 7 specimens: • 1 complete specimen (CMSTg13), 30°42.2679'N, 122°45.7230'E, 1 Dec 2024, other data same as holotype. • 3 complete specimens (CMSTT1, CMSTT2, CMSTT3), 30°42.2963'N, 122°46.1492'E, with other data the same as the holotype. • 3 specimens (CMSTT4, CMSTT5 incomplete, CMSTT6) 30°42.4181'N, 122°46.1410'E; other data same as holotype.

**Table 2.** GenBank and BOLD accession numbers, collection localities, and references for the COI and 16S rDNA sequences used in this study.

| Species | COI | 16S | Locality | Reference |
|---|---|---|---|---|
| *Arabella gouqi* sp. nov. | PV548907 | – | Gouqi Island, China | This study |
| | PX495939 | PX601586 | | |
| | PX495940 | – | | |
| | PX495941 | – | | |
| | PX495942 | PX610608 | | |
| | PX495943 | – | | |
| | PX495948 | PX610609 | | |
| | – | PX601587 | | |
| *Arabella* sp. | GU362693 | GU362681 | Qingdao, China | Zhou et al. 2010 |
| *Arabella* sp. | OQ323412 | – | Virginia, USA | Direct submission |
| | OQ323158 | – | | |
| | OQ323045 | – | | |
| | OQ322696 | – | | |
| *Arabella* sp. | – | HM746709 | Unknown | Paul et al. 2010 |
| *Arabella* sp. | – | LC787737 | Wakayama, Japan | Kobayashi and Abe 2024 |
| *Arabella* sp. | PV563047 | – | Nanji Island, China | Direct submission |
| | PV563048 | – | | |
| | PV563051 | – | | |
| *Arabella iricolor* Montagu,1804 | OR714261 | OR725145 | South Milton Sands, UK | Darbyshire and Kara 2024 |
| | OR714259 | OR725143 | Plymouth, UK | |
| | OR714260 | OR725144 | | |
| *Arabella semimaculata* Moore, 1911 | MK550647 | – | California, USA | Direct submission |
| | MK550651 | – | California, USA | |
| | AY838866 | GQ478123 | Unknown | Struck et al. 2006 |
| | – | AY838825 | | |
| *Arabella umgazanae* | OR714254 | OR725147 | Mngazana, South Africa | Darbyshire and Kara 2024 |
| | OR714255 | OR725148 | | |
| | – | OR725149 | | |
| | – | OR725150 | | |
| *Arabella ampulliformis* | OR714257 | OR725146 | Lundy Island, UK | Darbyshire and Kara 2024 |
| | OR714258 | – | South Milton Sands, UK | |
| | OR726620 | – | | |
| *Arabella protomutans* Orensanz, 1990 | OR714256 | OR725137 | Port San Carlos, Falkland Islands | Darbyshire and Kara 2024 |
| *Arabella* sp. | KANBI1433-19 | – | Hawaii, USA | Direct submission |
| | KANBI759-19 | – | | |
| | MW278749 | – | | |
| *Drilonereis filum* Claparède, 1868 | KT307638 | – | North Spain, Spain | Aylagas et al. 2016 |
| | – | OR725138 | Northumberland, UK | Darbyshire and Kara 2024 |
| *Drilonereis longa* Webster, 1879 | OQ323264 | – | Virginia, USA | Direct submission |
| | OQ323118 | – | | |
| | – | AY838828 | Unknown | Struck et al. 2006 |
| *Halla okudai* Imajima, 1967 | – | LC545402 | Fukue Island, Japan | Kobayashi et al. 2020 |
| | LC787733 | LC787732 | Nagasaki, Japan | Kobayashi and Abe 2024 |
| | LC830815 | LC830814 | Kanagawa, Japan | Nishi et al. 2024 |
| *Scoletoma laurentiana* Grube, 1863 | OR714262 | OR725139 | South Milton Sands, UK | Darbyshire and Kara 2024 |
| | – | OR725140 | | |

| Species | COI | 16S | Locality | Reference |
|---|---|---|---|---|
| *Oenone fulgida* Lamarck, 1818 | AY838872 | AY838838 | Unknown | Struck et al. 2006 |
| | – | GQ478124 | | Zanol et al. 2010 |
| *Lumbrineris* sp. | KR916858 | – | Faro, Portugal | Lobo et al. 2016 |
| | (BOLD: ACO5551) | | | |
| *Marphysa sanguinea* Montagu, 1813 | GQ497547 | GQ478157 | Unknown | Zanol et al. 2010 |
| | – | OR725142 | Plymouth, UK | |
| *Eunice norvegica* Linnaeus, 1767 | GQ497541 | GQ478147 | Unknown | Zanol et al. 2010 |
| | – | OR725141 | Dorset, UK | Darbyshire and Kara 2024 |

**GenBank accession numbers.** COI gene: PV548907, PX495939, PX495940, PX495941, PX495942, PX495943, and PX495948. 16S gene: PX601586, PX610608, PX610609, and PX601587.

**Etymology.** The specific name "*gouqi*" is obtained from the location where the specimens were collected, Gouqi Island, found in Zhejiang Province, China.

**Diagnosis.** Prostomium tapers anteriorly, with four eyes in a concave arrangement. Peristomium forms double rings. Maxillae with five plate pairs. Shapes both symmetrical and asymmetrical; MxI left bifid robust, right gracile falcate. Long right MxII, short left MxII. MxIII and MxIV with longest anterior-most tooth. MxV one tooth both sides. Maxillary carriers long and slender. Dorsal carriers longer than ventral. Short notopodial cirri. Prechaetal lobe rounded, shorter than chaetae. Posterior postchaetal lobe shorter than chaetae. Chaetae bilimbate, length decreases from median to both dorsal and ventral or dorsal to ventral only. Chaetae coarsely or finely serrated; ventralmost chaetae taper gradually to guards. Pygidium with one pair of distinct swollen pads.

**Description.** ***Holotype*****,** complete specimen, 58 mm long with 308 chaetigers. Width, 2 mm at chaetiger 10 and 2.5 mm at the central part, including parapodia. ***Paratypes*****.** 1 incomplete specimen, 103 mm long with 364 chaetigers. Width, 3 mm at chaetiger 10 and 3.2 mm at the central part, including parapodia. 3 complete specimens, 63–125 mm long with 330–524 chaetigers. Width, 1–3 mm at chaetiger 10 and 1.5–3.5 mm at the central part, including parapodia.

Body long, slender, dorsoventrally rounded, dorsal surface more convex. Widest centrally, maintaining width through most of its length, then gradually tapering to the pygidium. Preserved holotype and paratypes pale brown with dark spots forming dorsal lines throughout the body (Fig. 2A–C). Prostomium slightly shorter than peristomium. Posterior deeper than anterior end, dorsally in a slope, ventrally flattened with median groove from posterior to anterior (Fig. 2C, F). Prostomium eyes arranged in a concave shape. Median pair smaller than lateral (Fig. 2E). Peristomium of two distinct rings, both wider than prostomium (Fig. 2B, C, F).

Mandibles black, connected by short ligament, positioned anterior to maxillae when retracted, cutting plates shorter than the mandibular carriers, inner edge shorter than lateral (Fig. 3G). Dorsal maxillary carriers paired widest anteriorly, poorly defined posteriorly; ventral carrier unpaired, widest anteriorly, tapers posteriorly. Ventral carrier is about 2/3 the length of dorsal carriers (Figs 3H, 4A, C). Maxillae with five pairs of plates, symmetrical (MxIII, MxIV and MxV) or asymmetrical (MxI and MxII). MxI left bifid robust, right gracile falcate. Long right MxII, short left MXII. MxIII and MxIV with the longest anterior-most tooth, and MxV with one tooth on both sides. Maxillary formula: MxI teeth (2, (6–7)) + (1, (8–9)); MxII teeth (8–9) + (17–18); MxIII teeth 6+6; MxIV teeth 5+5; MxV teeth 1+1. (Fig. 4A, B).

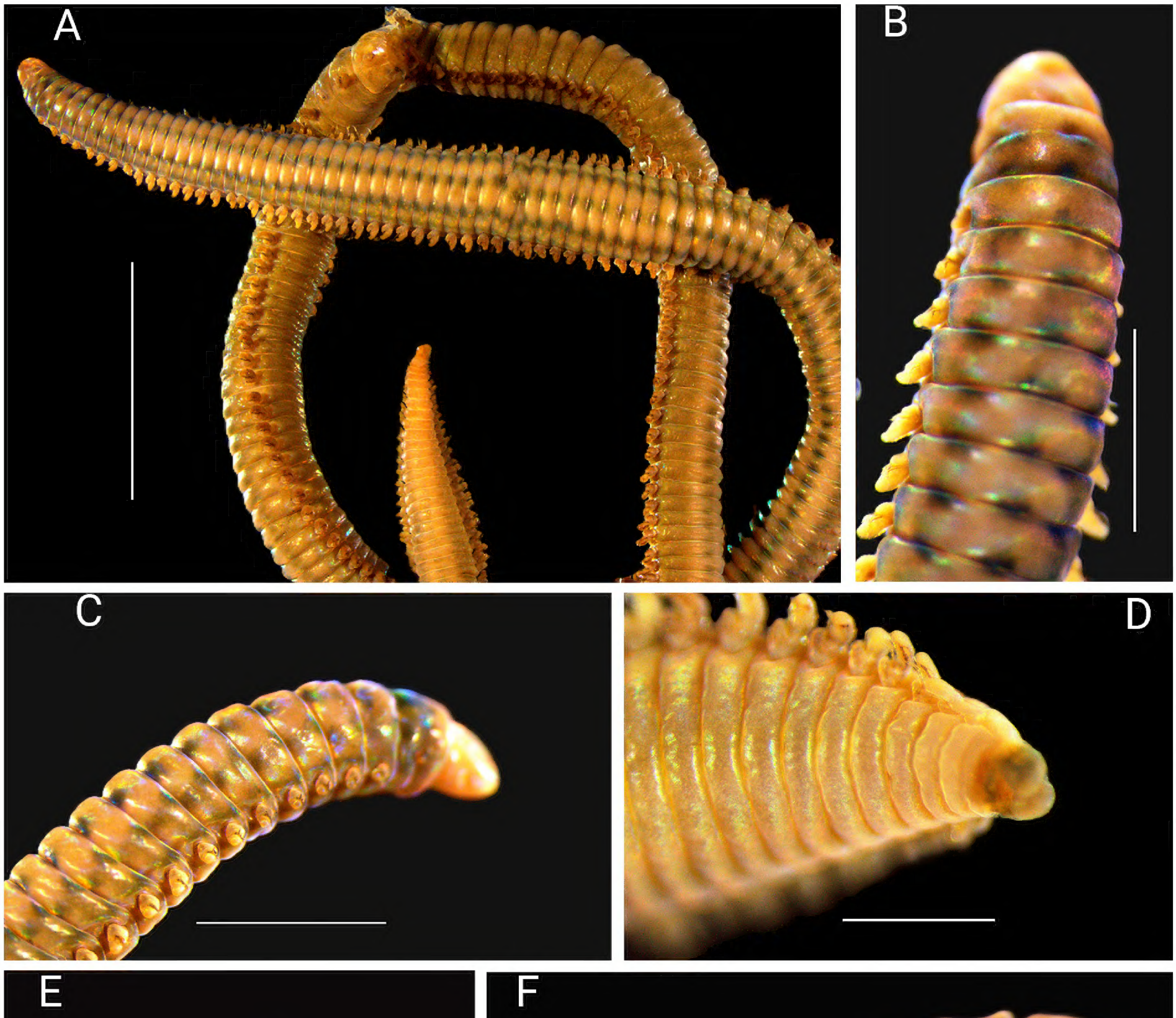


**Figure 2.** *Arabella gouqi* sp. nov. holotype CMSTT7 (**F**), paratype CMSTT6 (**A**), paratype CMSTT4 (**B**, **E**), paratype CMSTT5 (**C**) and paratype CMSTT1(**D**). **A.** Complete body; **B.** Body, anterior dorsal view; **C.** Anterior, dorsolateral view; **D.** Pygidium ventrolateral view; **E.** Prostomium with four eyes; **F.** Anterior body, ventral lateral view. Scale bars: 7 mm (**A**); 4 mm (**B**–**D**); 12 mm (**E**); 15 mm (**F**).

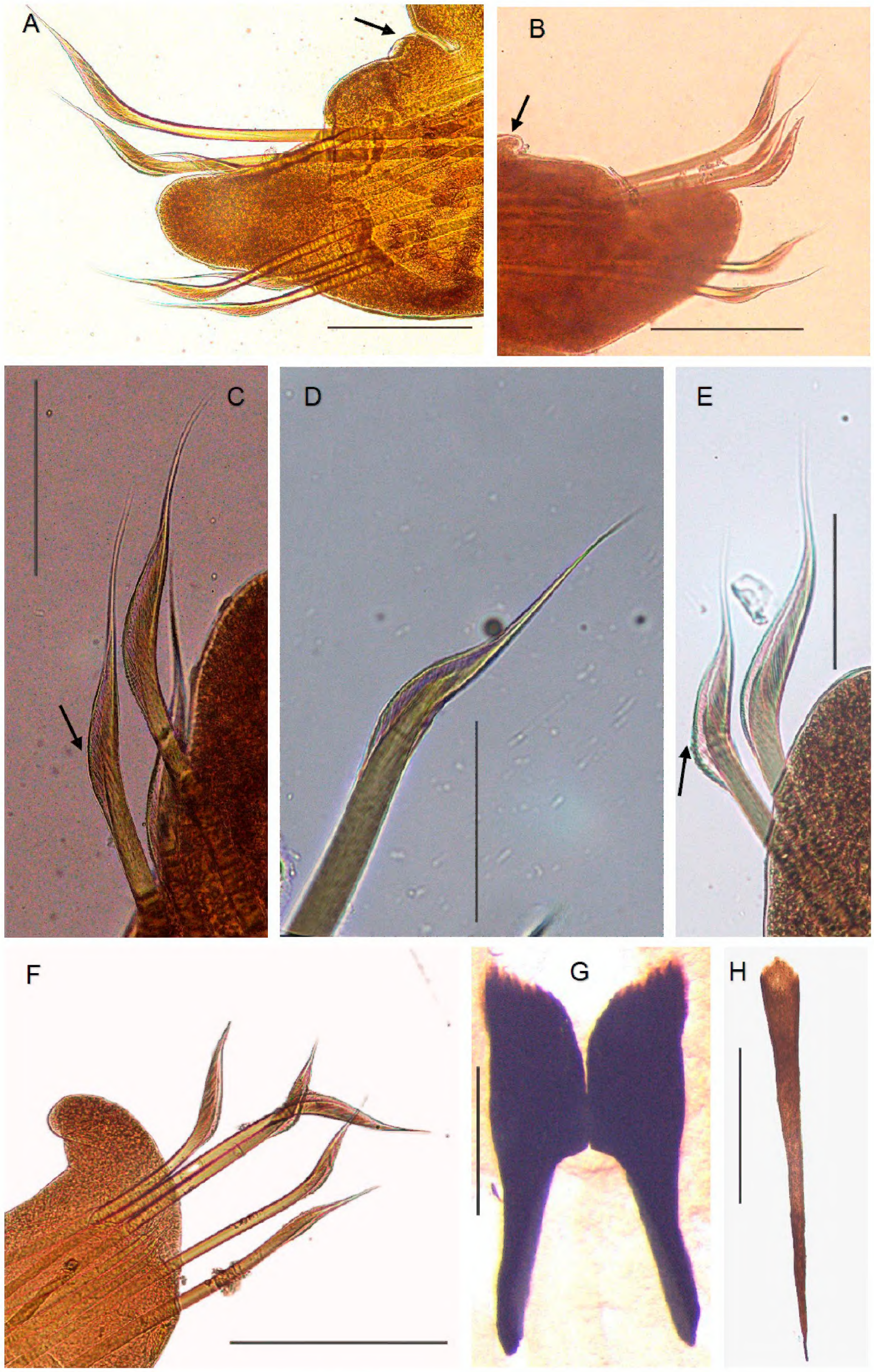


**Figure 3.** *Arabella gouqi* sp. nov. holotype CMSTT7 (**F**), paratype CMSTT4 (**B**, **D**, **E**), paratype CMSTT5 (**H**), and paratype CMSTT6 (**A**, **C**, **G**). **A.** Left parapodium 22 (arrow pointing to a notopodial cirri); **B.** Right parapodium 24 (arrow pointing to a notopodial cirri); **C.** Right parapodium 22 (arrow pointing to the ventralmost chaetae); **D.** Ventralmost chaetae, right parapodium 23; **E.** Dorsal and mediodorsal chaetae, left parapodium 25 (arrow pointing to coarsely serrated); **F.** Right parapodium 37; **G.** Mandibles; **H.** Ventral carrier**.** Scale bars: 8 mm (**A**, **B**); 2.8 mm (**C**, **F**); 1 mm (**D**, **E**); 3 mm (**G**, **H**).

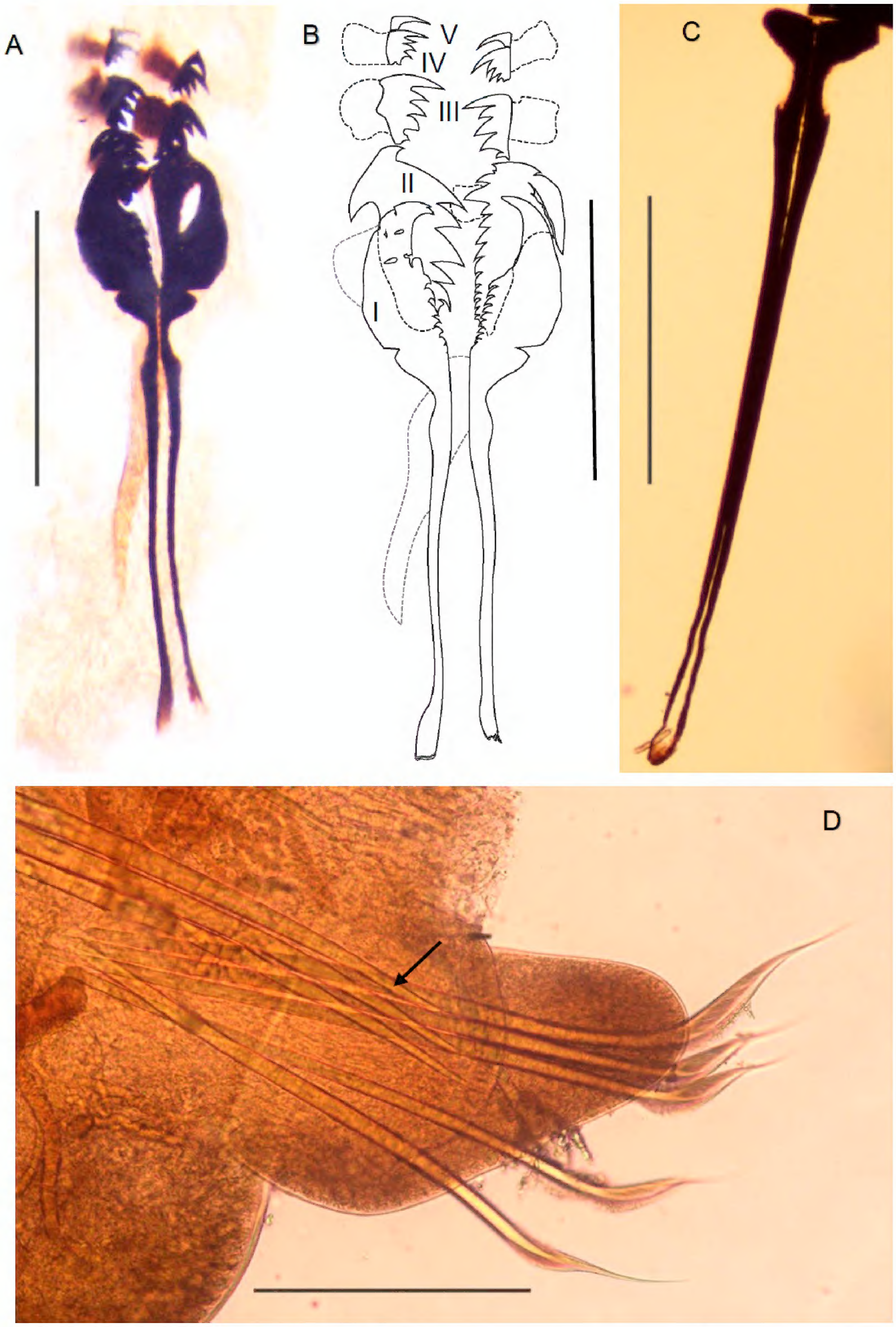


**Figure 4.** *Arabella gouqi* sp. nov. holotype CMSTT7 (**A**, **B**), paratype CMSTg13 (**C**), and paratype CMSTT4 (**D**). **A.** Maxillae (including ventral and dorsal carriers); **B.** Maxillae I–V; **C.** Dorsal carriers; **D.** Right parapodium 23 (arrow pointing to a notoacicula). Scale bars: 5 mm (**A**, **C**); 4 mm (**B**); 2.5 mm (**D**).

Prechaetal lobe rounded, shorter than chaetae. Posterior postchaetal lobe elongate but shorter than chaetae (Figs 3A, B, 4D). Short notopodial cirri present, observed clearly at the anterior and central chaetigers (Fig. 3A, B). 3 notoaciculae

present shorter than prechaetal lobe, neuroaciculae not observed (Fig. 4D). 5 to 7 bilimbate chaetae present (the number varies between specimens, but consistent throughout the body), dorsal or mediodorsal chaetae longer than others. Chaetae coarsely serrated (mediodorsal chaetae) or finely serrated (other chaetae), ventralmost chaetae taper gradually to guards (Figs 3A–F, 4D). Chaetal length decreases from median to both dorsal and ventral or dorsal to ventral only (Figs 3A, B, F, 4D). Pygidium with two distinct swollen pads (Fig. 2D).

**Distribution.** Currently known only from mussel farms in the sea off the coast of Gouqi Island in Zhejiang, China.

**Habitat.** Specimens of *A. gouqi* sp. nov. were obtained from the ropes used to hold mussels in mussel farms. The ropes were submerged in seawater to a depth of approximately 20 m.

**Remarks.** *Arabella gouqi* sp. nov. is characterized by a combination of the following features: a pygidium with two distinct swollen pads; short notopodial cirri; gradually tapering ventralmost chaetae; a bifid robust left MxI; a gracile falcate right MxI; a short left MxII; and a long right MxII.

The gradually tapering ventralmost chaetae have also been reported in *A. iricolor* Montagu 1804, *A. semimaculata* Moore, 1911, *Arabella turbidiricolor* (Kang et al. 2024), *A. protomutans* Orensanz, 1990, *Arabella aracaensis* Steiner & Amaral, 2009, *Arabella pulvinata* Zanol & Ruta, 2015, *Arabella logani* Crossland, 1924, *Arabella longicirrata* Hartmann-Schröder, 1979, *Arabella pectinata* Fauchald, 1970, *A. umgazanae*, and *A. ampulliformis* Darbyshire & Kara, 2024.

However, *A. iricolor*, *A. semimaculata*, *A. aracaensis*, *A. pulvinata*, *A. longicirrata*, and *A. turbidiricolor* are easily distinguished from *A. gouqi* sp. nov. by having a unidentate left MxI (vs. a bidentate left MxI in *A. gouqi* sp. nov.) (Moore 1911; Hartmann-Schröder 1979; Blake et al. 1995; Steiner and Amaral 2009; Zanol and Ruta 2015; Darbyshire and Kara 2024; Kang et al. 2024). Other *Arabella* species reported as having a unidentate left MxI are as follows: *Arabella cincta* Hartmann-Schröder, 1962, from Chile; *Arabella coeca* Fauvel, 1940, from the Adriatic Sea; *Arabella monroi* Colbath, 1989, from Ecuador; *Arabella robusta* Zanol & Ruta, 2015, from Australia; *Arabella atlantica* Crossland, 1924, from the Cape Verde Islands; *Arabella endonata*; and *Arabella longipedata* Monro, 1931, from Australia.

Of the species introduced above, *A. logani* Crossland, 1924, reported from the Gulf of Suez, Egypt, is very close to *A. gouqi* sp. nov. in the shapes of MxI and MxII, the pygidium, the ventralmost chaetae, and the length of the posterior postchaetal lobe in relation to the chaetae. However, the original description by Crossland (1924) shows clearly the presence of five notoaciculae in *A. logani* that differ from *A. gouqi* sp. nov., which has three notoaciculae. Moreover, *A. logani* has 8 chaetae in anterior chaetigers, which outnumber the 5 to 7 chaetae in *A. gouqi* sp. nov. (Darbyshire and Kara 2024). *Arabella umgazanae* Darbyshire & Kara, 2024, (described from Mngazana, South Africa) is closer to *A. gouqi* sp. nov. in having gradually tapering ventralmost chaetae, short notopodial cirri, a bifid left MxI, and a pygidium with one pair of swollen pads. However, the two species can be primarily distinguished by the shape of the pygidial lobes: in *A. umgazanae*, the lobes are semicircular (vs. circular/round lobes in *A. gouqi* sp. nov.). There are also some differences in the number of teeth on MXI, MXII, and MXIV. In addition, in *A. umgazanae*, chaetae decrease in

length from dorsal to ventral in all parapodia (vs. chaetal length decreases from median to both dorsal and ventral, or from dorsal to ventral, in *A. gouqi* sp. nov.).

Moreover, *A. protomutans* is similar to *A. gouqi* sp. nov. in the shape of MxI and MxII, the pygidium, the ventralmost chaetae, and the length of the posterior postchaetal lobe in relation to the chaetae. However, the two species differ in the denticulation of maxillae II and III (Orensanz 1990). *Arabella pectinata* Fauchald, 1970, (from Mexico, eastern Pacific) has all teeth evenly long in maxillae III and IV; in addition, each tooth has a short blunt tip; however, *A. gouqi* sp. nov. has alternately long and short teeth, with sharp tips and the longest anterior-most tooth in MxIII and MxIV (Fauchald 1970; Kang et al. 2024). On the other hand, *A. ampulliformis* Darbyshire & Kara, 2024, (reported from the UK) is distinguished from *A. gouqi* sp. nov. in possessing a pygidium with two pygidial lobes extended into short, stout cirri, ampulliform in lateral view (vs. a pygidium with two swollen pads in *A. gouqi* sp. nov.)

Of *A. iricolor* described outside of its original Europe (Montagu 1804) and before redescription by Darbyshire and Kara (2024), including those from America (Colbath 1989), Brazil (Ribeiro et al. 2018), Pakistan (Mustaquim 2000), Australia (Blake et al. 1995; Zanol and Ruta 2015), and Mexico (Fauchald 1970), all were described as having gradually tapering ventralmost chaetae, similar to *A. gouqi* sp. nov. However, with the exception of specimens from Pakistan for which the pygidium shape is unknown, the rest were described with a pygidium bearing at least two cirri (vs. two swollen pads in *A. gouqi* sp. nov.). Other specimens from Caribbean (Treadwell 1921) and Japan (Imajima and Hartman 1964; Uchida 1968) were also described with a pygidium of at least two cirri, which differs from the two swollen pads in *A. gouqi* sp. nov.

Comparisons of *A. gouqi* sp. nov. with other *Arabella* species reported from China, such as *Arabella renierii* Grube, 1877, are challenging due to the lack of detailed morphological descriptions from its original description. Other samples were reported as *A. iricolor* (Wang and Huang 1993; Zhou et al. 2010), but currently no updated morphological features are available for comparison. *Arabella mutans* Chamberlin, 1919, was listed as one of the species found in the East China Sea by Liu (2008). If the material from China resembles the original description, then *Arabella mutans* is easily distinguished from *A. gouqi* sp. nov. in having abruptly tapering ventralmost chaetae and a pygidium with four cirri (vs. gradually tapering ventralmost chaetae and two swollen pads in *A. gouqi* sp. nov.) (Chamberlin 1919; Zanol and Ruta 2015).

*Arabella zonata* Moore, 1903, reported from Japan, can easily be distinguished from *A. gouqi* sp. nov. by having a pygidium with a pair of short lateral cirri (Moore 1903; Hartman 1942) (vs. a pygidium forming two swollen pads with no cirri in *A. gouqi* sp. nov.). Other *Arabella* species, including *Arabella mutans*, Chamberlin, 1919, from Chile, and *Arabella panamensis* Colbath, 1989, from Costa Rica, were all described as having abruptly tapering ventralmost chaetae (Colbath 1989; Steiner and Amaral 2009; Zanol and Ruta 2015). This feature differs from *A. gouqi* sp. nov., which is characterized by gradually tapering ventralmost chaetae. *Arabella iridescens* Treadwell, 1906, reported from Hawaii (Hartman 1942), is easily differentiated from *A. gouqi* sp. nov. through the shape of right MXI and MXII. *Arabella iridescens* has a right MXI roughly triangular in outline (vs. gracile falcate right MXI in *A. gouqi* sp. nov.).

## Phylogenetic analysis and genetic divergence

The maximum likelihood (ML) trees produced from both COI and 16S rRNA sequences revealed *A. gouqi* sp. nov. in a separate monophyletic clade, as supported by 100% and 95% ML bootstrap values, respectively (Figs 5, 6). The K2P distances between *A. gouqi* sp. nov. and other known *Arabella* species ranged from 9.9% to 24.2% for COI and 5.5% to 25.2% for 16S rRNA (Tables 3, 4).

Other specimens identified as *A. iricolor* from the Nanji Islands in Zhejiang, China, were likewise placed in a unique monophyletic clade with 100% ML bootstrap support (Fig. 5). The K2P distance based on COI between *Arabella* sp. from Nanji Islands and *A. gouqi* sp. nov. was 14.5% (Table 3), indicating that both species are distinct. A specimen identified as *A. iricolor* from Qingdao in Shandong, China, was found in a distinct clade from *A. gouqi* sp. nov. in both COI and 16S rRNA ML trees (Figs 5, 6). The K2P distance between *Arabella* sp. from Qingdao and *A. gouqi* sp. nov., as determined by COI and 16S rRNA, was 17.3% and 11.0%, respectively (Tables 3, 4). Additionally, the Qingdao specimen was clustered in a separate clade with specimens from the Nanji Islands (Fig. 5), with a 16.8% K2P distance based on COI sequences (Table 3); these species were most likely misidentified.

Specimens reported as *A. iricolor* from China (Nanji Islands and Qingdao), the US (Virginia and Hawaii), and the UK (South Milton Sands and Plymouth) were all clustered in different clades in both COI and 16S rRNA ML trees (Figs 5, 6). The overall mean K2P distances between them were 20.0% and 16.0%, respectively (Tables 3, 4). However, specimens from South Milton Sands and Plymouth (UK) were clustered together with 100% and 98% ML bootstrap support in the COI and 16S rDNA ML trees, respectively (Figs 5, 6), indicating the occurrence of *A. iricolor* in the UK. The COI and 16S rDNA sequences of specimens from South Milton Sands and Plymouth (UK) showed K2P distances of 0.72% and 0.57%, respectively (Tables 3, 4). Other specimens reported as *A. iricolor* from Virginia and Hawaii were in separate clades (Fig. 5), with a K2P distance of 23.9% based on COI sequences (Table 3), indicating that they are distinct species.

**Table 3.** Genetic divergence (K2P) based on COI between *Arabella* species from different localities.

| | Species name | Locality | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *A. gouqi* sp. nov. (PX495941) | Gouqi Island, China | | | | | | | | | | |
| 2 | *A. semimaculata* (MK550651) | California, USA | 0.099 | | | | | | | | | |
| 3 | *Arabella* sp. (PV563047) | Nanji Islands, China | 0.145 | 0.148 | | | | | | | | |
| 4 | *A. protomutans* (OR714256) | Port San Carlos, Falkland Islands | 0.177 | 0.178 | 0.186 | | | | | | | |
| 5 | *A. semimaculata* (AY838866) | Unknown | 0.217 | 0.228 | 0.243 | 0.202 | | | | | | |
| 6 | *Arabella* sp. (OQ323412) | Virginia, USA | 0.190 | 0.196 | 0.226 | 0.197 | 0.216 | | | | | |
| 7 | *Arabella* sp. (GU362693) | Qingdao, China | 0.173 | 0.155 | 0.168 | 0.173 | 0.199 | 0.219 | | | | |
| 8 | *A. ampulliformis* (OR714257) | Lundy Island, UK | 0.215 | 0.206 | 0.251 | 0.220 | 0.225 | 0.208 | 0.202 | | | |
| 9 | *A. iricolor* (OR714260) | Plymouth, UK | 0.242 | 0.258 | 0.273 | 0.244 | 0.244 | 0.220 | 0.266 | 0.291 | | |
| 10 | *Arabella* sp. (KANBI1433-19) | Hawaii, USA | 0.223 | 0.213 | 0.254 | 0.272 | 0.205 | 0.239 | 0.239 | 0.261 | 0.250 | |
| 11 | *A. umgazanae* (OR714254) | Mngazana, South Africa | 0.194 | 0.200 | 0.212 | 0.174 | 0.244 | 0.181 | 0.187 | 0.170 | 0.251 | 0.253 |

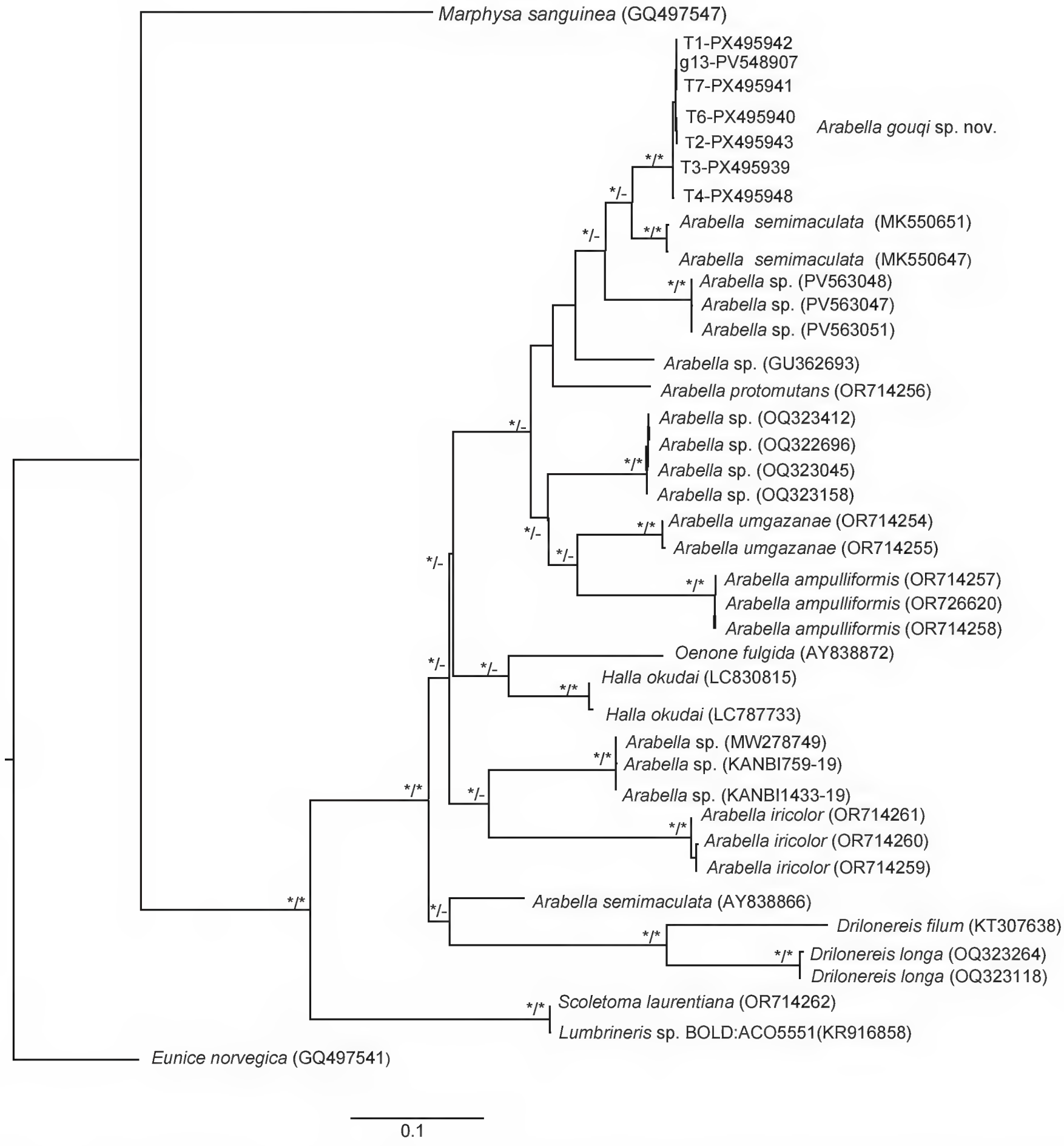


**Figure 5.** Maximum likelihood (ML) tree based on COI sequences of *Arabella* species from different localities. Asterisks (*/*) at nodes indicate clades with ≥ 95% bootstrap values. The scale bar represents substitutions per site.

*Arabella semimaculata* Moore, 1911, reported from California, USA, formed a unique monophyletic clade with a 99.9% ML bootstrap support (Fig. 5). Another *A. semimaculata* with GenBank accession number AY838866 (from an unknown location) proved to be in a different clade from the specimens derived from California, USA (Fig. 5). Their K2P distance based on COI was 22.9% (Table 3); thus, they are separate species. On the 16S rDNA phylogenetic tree, *A. semimaculata* with GenBank accession numbers AY838838 and GQ478124 were clustered together with 99% ML bootstrap support. These specimens may have been collected in the same region. There are no 16S rDNA sequences available for *A. semimaculata* from California, USA; therefore, comparisons were impossible.

Another *Arabella* species reported from Mngazana, South Africa, *A. umgazanae* Darbyshire & Kara, 2024, was clustered together in COI and 16S

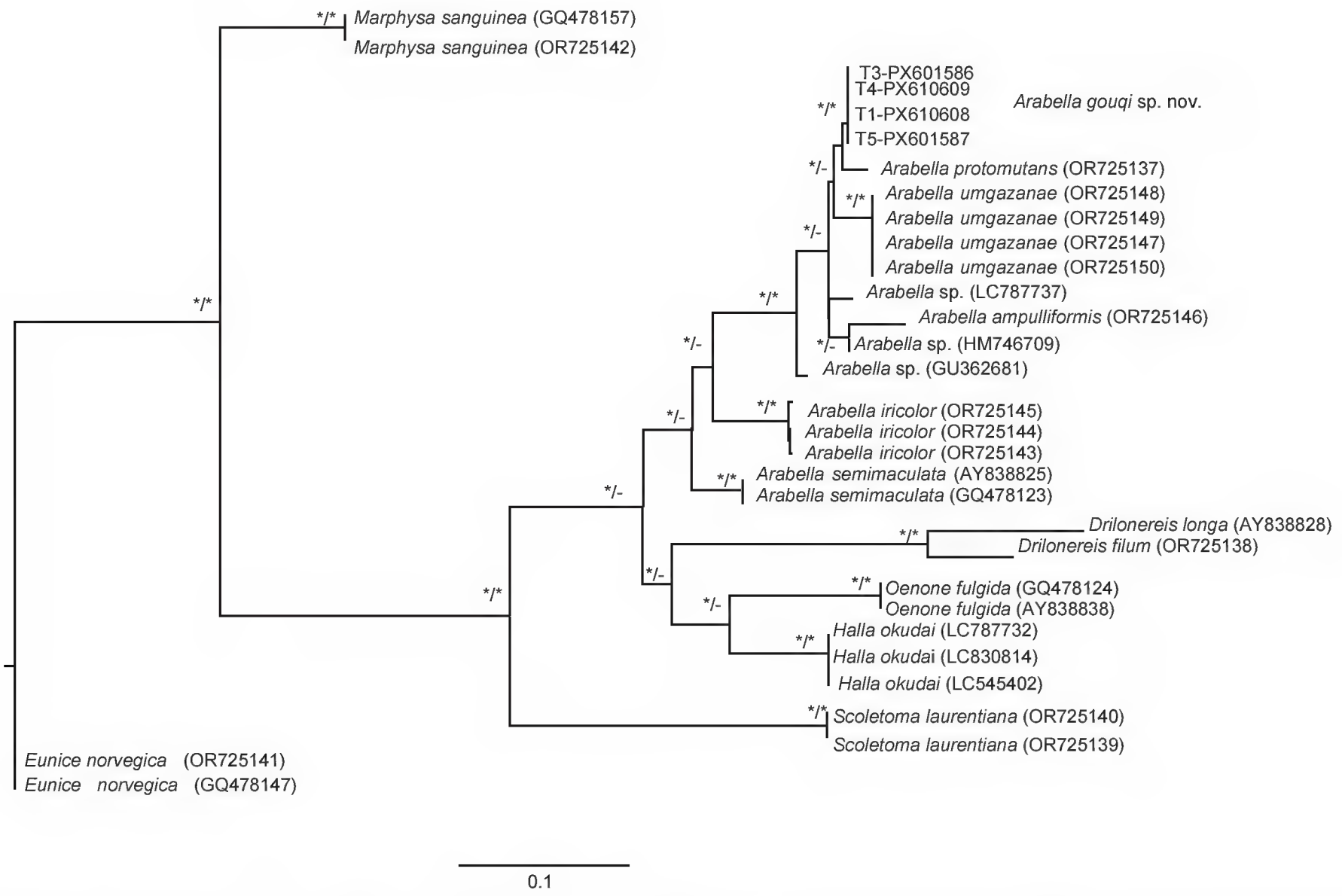


**Figure 6.** Maximum likelihood (ML) tree based on 16S rDNA sequences of *Arabella* species from different localities. Asterisks (*/*) at nodes indicate clades with ≥ 95% bootstrap values. The scale bar represents substitutions per site.

**Table 4.** Genetic divergence (K2P) based on 16S rDNA between *Arabella* species from different localities.

| | Species name | Locality | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *A. gouqi* sp. nov. (PX610608) | Gouqi Island, China | | | | | | | | |
| 2 | *A. semimaculata* (AY838825) | Unknown | 0.245 | | | | | | | |
| 3 | *A. protomutans* (OR725137) | Port San Carlos, Falkland Islands | 0.112 | 0.177 | | | | | | |
| 4 | *A. ampulliformis* (OR725146) | Lundy Island, UK | 0.133 | 0.234 | 0.102 | | | | | |
| 5 | *A. umgazanae* (OR725147) | Mngazana, South Africa | 0.068 | 0.186 | 0.086 | 0.116 | | | | |
| 6 | *A. iricolor* (OR725144) | Plymouth, UK | 0.252 | 0.145 | 0.201 | 0.238 | 0.234 | | | |
| 7 | *Arabella* sp. (GU362681) | Qingdao, China | 0.110 | 0.188 | 0.098 | 0.131 | 0.118 | 0.195 | | |
| 8 | *Arabella* sp. (HM746709) | Unknown | 0.107 | 0.188 | 0.096 | 0.100 | 0.086 | 0.212 | 0.108 | |
| 9 | *Arabella* sp. (LC787737) | Wakayama, Japan | 0.055 | 0.220 | 0.087 | 0.087 | 0.089 | 0.224 | 0.104 | 0.080 |

rRNA ML trees, with 100% bootstrap support (Figs 5, 6). *Arabella ampulliformis* Darbyshire & Kara, 2024, reported from the UK, formed a distinct monophyletic clade, supported by 100% bootstrap support on the COI tree.

## Discussion

The combined updated morphological and molecular analyses provide strong evidence that the specimens collected from the sea off Gouqi Island represent a new species, *A. gouqi* sp. nov. This study constitutes the first documented occurrence of the genus *Arabella* in the East China Sea, supported by detailed morphological and molecular evidence.

Morphologically, *A. gouqi* sp. nov. is characterized by a combination of a pygidium with two distinct swollen pads; short notopodial cirri; gradually tapering

ventralmost chaetae; a bifid robust left MxI and a gracile falcate right MxI; a short left MxII and a long right MxII. As suggested by Colbath (1989), Zanol and Ruta (2015), Zanol et al. (2021), Darbyshire and Kara (2024), and Kang et al. (2024), the provided combination of features is crucial and enough to differentiate *A. gouqi* sp. nov. from its closely related species.

Other *Arabella* species, including *A. mutans* Chamberlin, 1919, found in the East China Sea, were listed by Liu (2008); however, no detailed morphological support is available. In addition, Zhou et al. (2010) and other records available in GenBank reported the occurrence of *A. iricolor* from Qingdao and Nanji Islands, respectively. Apparently, *A. gouqi* sp. nov. is genetically distinct from all these species. This highlights unresolved taxonomic complexity in this region and requires more careful redescription of all previously reported *Arabella* species in this and nearby regions.

The present study also reveals a more localized distribution of *Arabella*, as recently pointed out by Darbyshire and Kara (2024) in the redescription of *A. iricolor* Montagu, 1804, and Kang et al. (2024). Our study supports that all specimens previously identified as *A. iricolor* should be revised before using this name, because, apart from the specimens reported in the UK, other specimens reported as *A. iricolor* from other places, including China (Nanji Islands and Qingdao) and the US (Virginia and Hawaii), were all phylogenetically reciprocally separate.

## Conclusions

This study describes a new species of *Arabella* using integrated morphological and molecular data. It constitutes the first documented occurrence of the genus *Arabella* in the East China Sea based upon morphological and molecular evidence. To characterize this new species, we used updated morphological traits, including the maxillary apparatus, ventralmost chaetae, notopodial cirri, and pygidium. This study provides essential data for understanding the taxonomy of *Arabella* in the East China Sea and emphasizes the need for further research on this group in the region.

## Acknowledgements

We thank Xiaopeng Gong and Yanqun Wang of Zhejiang Ocean University for their assistance in the laboratory analysis.

## References

Aljanabi S, Martinez I (1997) Universal and rapid salt-extraction of high-quality genomic DNA for PCR-based techniques. Nucleic Acids Research 25: 4692–4693. https://doi.org/10.1093/nar/25.22.4692

Aylagas E, Borja A, Irigoien X, Rodriguez-Ezpeleta N (2016) Benchmarking DNA metabarcoding for biodiversity-based monitoring and assessment. Frontiers in Marine Science 3: 96. https://doi.org/10.3389/fmars.2016.00096

Blake J, Hilbig B, Scott P (1995) Taxonomic atlas of the benthic fauna of the Santa Maria Basin and Western Santa Barbara Channel: The Annelida, part 2, Polychaeta: Phyllodocida (Syllidae and scale bearing families), Amphinomida, and Eunicida. In: Blake J, Hilbig B, Scott P (Eds), 315–339.

Bonyadi-Naeini A, Rahimian H, Glasby CJ (2016) A new substance to relax polychaete worms (Annelida) prior to morphological study. ZooKeys 594: 1–9. https://doi.org/10.3897/zookeys.594.8061

Carr CM, Hardy SM, Brown TM, Macdonald TA, Hebert PDN (2011) A tri-oceanic perspective: DNA barcoding reveals geographic structure and cryptic diversity in Canadian polychaetes. PLOS ONE 6: e22232. https://doi.org/10.1371/journal.pone.0022232

Chamberlin RV (1919) The Annelida Polychaeta [Albatross Expeditions]. Memoirs of the Museum of Comparative Zoology at Harvard College 48: 1–514. https://doi.org/10.5962/bhl.title.49195

Claparède É (1868) Les annélides chétopodes du Golfe de Naples. Mémoires de la Société de Physique et d'Histoire Naturelle de Genève 19: 313–584.

Colbath GK (1989) A revision of *Arabella mutans* (Chamberlin, 1919) and related species (Polychaeta: Arabellidae). Proceedings of the Biological Society of Washington 102: 283–299. http://pascal-francis.inist.fr/vibad/index.php?action=getRecordDetail&idt=7338193

Crossland C (1924) Polychaeta of Tropical East Africa, the Red Sea, and Cape Verde Islands collected by Cyril Crossland, and of the Maldive Archipelago collected by Professor Stanley Gardiner, MA, FRS. Proceedings of the Zoological Society of London 94(1): 1–106. https://doi.org/10.1111/j.1096-3642.1924.tb01490.x

Dales RP (1962) The polychaete stomodeum and the inter-relationships of the families of Polychaeta. Proceedings of the Zoological Society of London 139(3): 389–428. https://doi.org/10.1111/j.1469-7998.1962.tb01837.x

Darbyshire T (2014) Intertidal and nearshore Nereididae (Annelida) of the Falkland Islands, southwestern Atlantic, including a new species of *Gymnonereis*. ZooKeys 427: 75–108. https://doi.org/10.3897/zookeys.427.7296

Darbyshire T, Kara J (2024) Redescription of *Arabella iricolor* (Montagu, 1804) with descriptions of two new species from the United Kingdom and South Africa. African Zoology 60(1–2): 1–21. https://doi.org/10.1080/15627020.2024.2306421

Fauchald K (1970) Polychaetous annelids of the families Eunicidae, Lumbrineridae, Iphitimidae, Arabellidae, Lysaretidae and Dorvilleidae from western Mexico. Allan Hancock Monographs in Marine Biology 5: 1–335.

Fauvel P (1940) Annélides Polychètes de la Haute-Adriatique. Thalassia, Jena 4: 1–24.

Felsenstein J (1985) Confidence limits on phylogenies: An approach using the bootstrap. Evolution 39(4): 783–791. https://doi.org/10.1111/j.1558-5646.1985.tb00420.x

Grube AE (1850) Die Familien der Anneliden. Archiv für Naturgeschichte, Berlin. 16(1): 249–364. https://biodiversitylibrary.org/page/6958350

Grube AE (1863) Beschreibung neuer oder wenig bekannter Anneliden. Sechster Beitrag. Archiv für Naturgeschichte, Berlin. 29: 37–69. https://doi.org/10.5962/bhl.part.9306

Grube AE (1877) Übereine Sammlung von wirbellosen Seethieren, welche Herr Dr. Eugen Reimann dem hiesigen zoologischen Museum zum Geschenk gemacht. Jahres-Bericht der Schlesischen Gesellschaft für vaterländische Kultur, Breslau 54: 48–51.

Hall T (2011) BioEdit: an important software for molecular biology. GEFR Bulletin of Bioscience 2(1): 60–61.

Hartman O (1942) The identity of some marine annelid worms in the United States National Museum. Proceedings of the United States National Museum 92: 101–140. https://doi.org/10.5479/si.00963801.92-3142.101

Hartmann-Schröder G (1962) Die Polychaeten des Eulitorals. In: Hartmann-Schröder G, Hartmann G (Eds), Zur Kenntnis des Eulitorals der chilenischen Pazifikküste und der argentinischen Küste Südpatagoniens unter besonderer Berücksichtigung der

Polychaeten und Ostracoden. Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut 60: 57–270.

Hartmann-Schröder G (1979) Die Polychaeten der "Atlantischen Kuppenfahrt" von FS "Meteor" (Fahrt 9 c, 1967), 1. Proben aus Schleppgeräten. Meteor Forschungsergebnisse: Reihe D, Biologie 31: 63–90.

Imajima M (1967) Errant polychaetous annelids from Tsukumo Bay and vicinity of Noto Peninsula, Japan. Bulletin of the National Science Museum, Tokyo 10(4): 403–441. https://doi.org/10.5134/175453

Imajima M, Hartman O (1964) The polychaetous annelids of Japan. Part I and II. Allan Hancock Foundation Publications, Occasional Papers 26(1964): 1–452.

Kang SH, Jeong YS, Choi HK, Yoon SM (2024) A New Species of *Arabella* (Annelida, Polychaeta, Oenonidae) from Korean Waters. Animal Systematics, Evolution and Diversity 40(3): 157–166. https://doi.org/10.5635/ASED.2024.40.3.039

Kara J, Santos C, Macdonald A, Simon C (2020) Resolving the taxonomic identities and genetic structure of two cryptic *Platynereis* Kinberg species from South Africa. Invertebrate Systematics 34(6): 618–636. https://doi.org/10.1071/IS19072

Kimura M (1980) A simple method for estimating evolutionary rates of base substitutions through comparative studies of nucleotide sequences. Journal of Molecular Evolution 16(2): 111–120. https://doi.org/10.1007/BF01731581

Kinberg JGH (1865) Annulata nova. Öfversigt af Königlich Vetenskapsakademiens förhandlingar, Stockholm 21: 167–179.

Kobayashi G, Abe H (2024) Cost-efficient PCR based DNA barcoding of marine invertebrate specimens with NovaSeq amplicon sequencing. Molecular Biology Reports 51(1): 887. https://doi.org/10.1007/s11033-024-09811-z

Kobayashi G, Mukai R, Itoh H (2020) New record of *Halla okudai* Imajima, 1967 (Annelida, Eunicida, Oenonidae) from Fukue Island in the Goto Islands, Japan. Check List 16(5): 1199–1203. https://doi.org/10.15560/16.5.1199

Kumar S, Stecher G, Suleski M, Sanderford M, Sharma S, Tamura K (2024) Molecular Evolutionary Genetic Analysis Version 12 for Adaptive and Green Computing. Molecular Biology and Evolution 41(12): msae263. https://doi.org/10.1093/molbev/msae263

Lamarck JB (1818) Histoire naturelle des Animaux sans Vertèbres, présentant les caractères généraux et particuliers de ces animaux, leur distribution, leurs classes, leurs familles, leurs genres, et la citation des principales espèces qui s'y rapportent; precedes d'une Introduction offrant la determination des caractères essentiels de l'Animal, sa distinction du vegetal et desautres corps naturels, enfin, l'Exposition des Principes fondamentaux de la Zoologie. Paris, Deterville.

Liu JY (2008) Checklist of Marine Biota of China Seas. China Science Press, Beijing, 1267.

Lobo J, Teixeira MA, Borges LM, Ferreira MS, Hollatz C, Gomes PT, Sousa R, Ravara A, Costa MH, Costa FO (2016) Starting a DNA barcode reference library for shallow water polychaetes from the southern European Atlantic coast. Molecular Ecology Resources 16(1): 298–313. https://doi.org/10.1111/1755-0998.12441

Mohammad MBM (1981) Malformations in some polychaete annelids from Kuwait, Arabian Gulf. Hydrobiologia 78: 129–131. https://doi.org/10.1007/BF00007586

Monro CCA (1931) Polychaeta, Oligochaeta, Echiuroidea and Sipunculoidea. Scientific Reports of the Great Barrier Reef Expedition 1928–29, British Museum (Natural History) 4: 1–37.

Montagu G (1804) Description of several marine animals found on the south coast of Devonshire. Transactions of the Linnean Society of London 7(1): 61–85. https://doi.org/10.1111/j.1096-3642.1804.tb00282.x

Montagu G (1813) Descriptions of several new or rare animals, principally marine, discovered on the south coast of Devonshire. Transactions of the Linnean Society of London. 11(1): 1–26. https://doi.org/10.1111/j.1096-3642.1813.tb00035.x

Moore JP (1903) Polychaeta from the coastal slope of Japan and from Kamchatka and Bering Sea. Proceedings of the Academy of Natural Sciences of Philadelphia 55: 401–490. http://www.jstor.org/stable/4062908

Moore JP (1911) The polychaetous annelids dredged by the U.S.S. "Albatross" off the coast of Southern California in 1904. III. Euphrosynidae to Goniadidae. Proceedings of the Academy of Natural Sciences of Philadelphia 63: 234–318. https://www.jstor.org/stable/4063380

Mustaquim J (2000) Six new records of intertidal polychaetes from Pakistan. Pakistan Journal of Marine Sciences 9: 97–106.

Nei M, Kumar S (2000) Molecular Evolution and Phylogenetics. Oxford University Press, New York.

Nishi E, Unagami T, Taru M, Yokooka H, Kanaya G, Yuhara T, Kobayashi G, Abe H, Yokoyama K (2024) Record of *Halla okudai* (Annelida: Oenonidae) from the intertidal sandy mud of Ena Bay, Miura Peninsula, Kanagawa Prefecture 66: 104–108. https://doi.org/10.5179/benthos.79.66

Orensanz JM (1990) The Eunicemorph polychaete annelids from Antarctic and Subantarctic Seas. With addenda to the Eunicemorpha of Argentina, Chile, New Zealand, Australia, and the Southern Indian Ocean. Antarctic Research Series 52: 1–183. https://doi.org/10.1029/AR052p0001

Paik EI (1989) Illustrated encyclopedia of fauna and flora of Korea. Polychaeta, Ministry of Education, Seoul, 31: 441–443.

Palumbi SR (1996) Nucleic acids II: The polymerase chain reaction. In: Hillis DM, Moritz C, Mable BK (Eds) Molecular Systematics. Sinauer Associates, Sunderland, MA, 205–247.

Park T (2018) Taxonomic study on the selected nereidid species (Annelida: Polychaeta) from northeast Asian waters based on morphological and molecular data. Seoul National University.

Paul C, Halanych KM, Tiedemann R, Bleidorn C (2010) Molecules reject an opheliid affinity for *Travisia* (Annelida). Systematics and Biodiversity 8(4): 507–512. https://doi.org/10.1080/14772000.2010.517810 .517810

Rambaut A (2012) FigTree v1.4. Molecular evolution, phylogenetics and epidemiology. University of Edinburgh, Institute of Evolutionary Biology, Edinburgh.

Read G, Fauchald K [Ed.] (2025) World Polychaeta Database. *Arabella* Grube, 1850.https://marinespecies.org/deepsea/aphia.php?p=taxdetails&id=129199%20on%202025-11-09

Rho BJ, Song KH (1975) On the classification and the distribution of the marine benthic animals in Korea: 2. Polychaetous annelids. Journal of Korean Research Institute for Better Living 54: 95–118.

Ribeiro RP, Alves PR, Almeida ZS, Ruta C (2018) A new species of *Paraonis* and an annotated checklist of polychaetes from mangroves of the Brazilian Amazon Coast (Annelida, Paraonidae). ZooKeys 740: 1–34. https://doi.org/10.3897/zookeys.740.14640

Steiner TM, Amaral ACZ (2009) *Arabella aracaensis*, a new species with growth rings on its mandibles, and some remarks on the endoparasitic *Labrorostratus prolificus* (Polychaeta: Oenonidae) from southeast Brazil. Journal of Natural History 43(41–42): 2537–2551. https://doi.org/10.1080/00222930903219988

Struck TH, Purschke G, Halanych KM (2006) Phylogeny of Eunicida (Annelida) and exploring data congruence using a partition addition bootstrap alteration (PABA) approach. Systematic Biology 55(1): 1–20. https://doi.org/10.1080/10635150500354910

Thompson JD, Higgins DG, Gibson TJ (1994) CLUSTAL W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. Nucleic acids research 22(22): 4673–4680. https://doi.org/10.1093/nar/22.22.4673

Treadwell AL (1906) Polychaetous annelids of the Hawaiian Islands collected by the steamer Albatross in 1902. Bulletin of the United States Fish Commission 23: 1145–1181.

Treadwell AL (1921) Leodicidae of the West Indian region. Carnegie Institute of Washington Publication 15: 1–131. https://doi.org/10.5962/bhl.part.20335

Uchida H (1968) Polychaetous Annelids from Shakotan (Hokkaido): I. The Collection in 1967 (With 12 Text-figures and 1 Table). Journal of the Faculty of Science, Hokkaido University. Series VI, Zoology 16(4): 595–612. https://hdl.handle.net/2115/27468

Wang J, Huang Z (1993) Fouling polychaetes of Hong Kong and adjacent waters. Asian Marine Biology 10: 1–12.

Webster HE (1879) The Annelida Chaetopoda of the Virginian coast. Transactions of the Albany Institute 9: 202–269, plates. https://doi.org/10.5962/bhl.title.11296

Zanol J, Carrera-Parra LF, Steiner TM, Amaral ACZ, Wiklund H, Ravara A, Budaeva N (2021) The current state of Eunicida (Annelida) systematics and biodiversity. Diversity 13(2): 74. https://doi.org/10.3390/d13020074

Zanol J, Halanych KM, Struck TH, Fauchald K (2010) Phylogeny of the bristle worm family Eunicidae (Eunicida, Annelida) and the phylogenetic utility of noncongruent 16S, CO1 and 18S in combined analyses. Molecular Phylogenetics and Evolution 55(2): 660–676. https://doi.org/10.1016/j.ympev.2009.12.024

Zanol J, Ruta C (2015) New and previously known species of Oenonidae (Polychaeta: Annelida) from Lizard Island, Great Barrier Reef, Australia. Zootaxa 4019(1): 745–772. https://doi.org/10.11646/zootaxa.4019.1.26

Zhang Z, Schwartz S, Wagner L, Miller W (2000) A greedy algorithm for aligning DNA sequences. Journal of Computational Biology 7(1–2): 203–214. https://doi.org/10.1089/10665270050081478

Zhou H, Zhang Z, Chen H (2010) Integrating a DNA barcoding project with an ecological survey: a case study on temperate intertidal polychaete communities in Qingdao, China. Chinese Journal of Oceanology and Limnology 28: 899–910. https://doi.org/10.1007/s00343-010-9131-1

## Supplementary material 1

### Sample collection sites

Authors: Yehoshafati Elton Anton, Amiri Rajabu Mohamedi, Yongjiu Chen

Data type: xlsx

Explanation note: The location where specimens were colleted, at the Sea off the coast of Gouqi Island, Zhejiang, China.

Copyright notice: This dataset is made available under the Open Database License (http://opendatacommons.org/licenses/odbl/1.0/). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.

Link: https://doi.org/10.3897/zookeys.1278.182033.suppl1

## Supplementary material 2

### Newick Export for CO1 ML phylogenetic tree

Authors: Yehoshafati Elton Anton, Amiri Rajabu Mohamedi, Yongjiu Chen
Data type: nwk
Explanation note: Export file used for contruction of CO1 ML phylogenetic tree.
Copyright notice: This dataset is made available under the Open Database License (http://opendatacommons.org/licenses/odbl/1.0/). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.
Link: https://doi.org/10.3897/zookeys.1278.182033.suppl2

## Supplementary material 3

### Newick Export for 16S ML phylogenetic tree

Authors: Yehoshafati Elton Anton, Amiri Rajabu Mohamedi, Yongjiu Chen
Data type: nwk
Explanation note: Newick Export file for 16S ML phylogenetic tree.
Copyright notice: This dataset is made available under the Open Database License (http://opendatacommons.org/licenses/odbl/1.0/). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.
Link: https://doi.org/10.3897/zookeys.1278.182033.suppl3

## Additional information

### Conflict of interest

The authors have declared that no competing interests exist.

### Ethical statement

No ethical statement was reported.

### Artificial Intelligence (AI) use

The authors accept full responsibility for the content of the manuscript, including the disclosure of any use of AI.
No AI tools were used in the preparation of this manuscript.

### Funding

The work was supported by the Nanji Islands National Marine Nature Reserve of China (NJKJ-2017-014).

### Author contributions

Conceptualization: YEA, YC. Methodology: YEA, ARM. Software: YEA. Formal analysis: YEA. Investigation: YEA, ARM. Resources: YC. Data Curation: YEA, ARM. Writing-Original draft: YEA. Writing-Review and Editing: YEA, YC. Visualization: YEA, YC, ARM. Supervision: YC. Project administration: YC. Funding Acquisition: YC.

### Author ORCIDs

Y.E. Anton https://orcid.org/0009-0003-0143-6260
A.R. Mohamedi https://orcid.org/0009-0000-3747-1242
Y. Chen https://orcid.org/0000-0002-1591-3190

### Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.